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Medical Surveillance Monthly Report

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Army Medical Surveillance Activity (AMSA)

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Surveillance Summary

Spontaneous Fractures of the Femur, Active Duty Soldiers

Background: "Spontaneous" or "pathologic" fractures are those that occur in the absence of trauma sufficient to disrupt the integrity of normal bone. Spontaneous fractures can be thought of as "opportunistic" fractures since they occur in bones that are weakened, for example, by tumors, nutritional or metabolic abnormalities, or prior injury (e.g., fracture, surgical repair). In an otherwise healthy adult, a spontaneous fracture can occur as an unusual manifestation of the adaptive process of bone remodeling in response to changes in physical activity ("stress" fractures). For centuries, spontaneous fractures, particularly of the lower extremities, have threatened the health and effectiveness of military forces, particularly during "recruit training." This report summarizes recent experiences regarding spontaneous fractures of the femur among trainees at Fort Leonard Wood, Missouri, and Armywide.

Recent experience: In November 1997, the USACHPPM was informed that, since the beginning of the year, there had been nine fractures of the neck or shaft of the femur among trainees at Fort Leonard Wood, Missouri. All were considered "spontaneous", and all required surgical intervention for internal stabilization. Six of the fractures (67% of the total) were among females. In a four week period of October-November, there were four cases among female trainees who had recently or nearly completed training.

Armywide experience: From 1994 through 1996, the Armywide hospitalization rate for "spontaneous fractures of the neck or other part of the femur" (ICD-9 code: 733.14-733.15) was 3.46 per 100,000 soldiers per year (soldier-years). Between October 1993 and December 1996, 82 hospitalizations for these unusual injuries accounted for 2,588 lost duty days (or slightly more than seven lost soldier-years). The mean number of lost days was 31.6 while the highest number was 401. More than half (n=44) of the hospitalized cases required surgical procedures for internal fixation of the fracture site.

Nearly 90% of the cases were soldiers in the four most junior enlisted grades – in fact, nearly half were in the lowest grade (PVT, E1). In contrast, no cases were officers above the rank of first lieutenant (figure 1). More than 70% (n=58) of the cases presented during the first six months of military service, and nearly 40% (n=31) were in the third or fourth month, a period of advanced individual training (AIT) for most soldiers (figure 2, page 9).

Females accounted for more than half of all cases (n=43). The hospitalization rate among females was more than ten-fold that among males (females: 17.49/100,000 soldier-years; males: 1.64/100,000 soldier-years; F:M ratio=10.7) (figure 3, page 9).

Relatively more cases occurred among soldiers who were white nonhispanic (WNH) than

Executive Editor
John F. Brundage, MD, MPH

Editor
LTC Mark V. Rubertone, MD, MPH

Managing Editor
Kimmie Kohlhase, MS

Writer / Editor
MAJ Lisa Pearse, MD, MPH

Prepared by the Medical Surveillance Activity, Directorate of Epidemiology and Disease Surveillance, United States Army Center for Health Promotion and Preventive Medicine.
Inquiries regarding content or material to be considered for publication should be directed to the editor, Army Medical Surveillance Activity, Bldg. T-20, Rm 213, Washington DC, 20307-5100. E-mail: "ltc_mark_rubertone@wrsmtp-ccmail.army.mil"
Publishing office is the Executive Communications Division, United States Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, Maryland 21010-5422.
To be added to the mailing list, contact the Army Medical Surveillance Activity @ DSN 662-0471, Comm: (202) 782-0471.

other racial or ethnic subgroups – in fact, three-fourths (n=61) of cases were white nonhispanic (figure 4, page 9). Among junior enlisted, the hospitalization rate among white nonhispanic soldiers was nearly twice that among black nonhispanic (rate ratio, WNH:BNH = 1.98), and nearly 30% higher than among hispanic or other ethnic minority (rate ratio, WNH:hispanic/other = 1.27), soldiers. As a consequence, the rate among white nonhispanic, junior enlisted, female soldiers (54.95 per 100,000 soldier-years) was more than 15 times higher than that of the Army overall.

More cases occurred among soldiers with medical occupational specialties (MOS: 91, n=15) than any other (table, page 8). Only three other military occupational series had as many as five cases: infantry (MOS: 11, n=11), communications (MOS: 31, n=9), and armor (MOS: 19, n=6).

Finally, installations with large basic and advanced individual training missions were affected more than others (table, page 8). For example, more cases (n=14) were treated at Brooke Army Medical Center, Fort Sam Houston, than any other hospital. Hospitals at Benning (n=9), Knox (n=9), Leonard Wood (n=9), Gordon (n=7), and Jackson (n=6) also treated more than five cases each.

Editorial comment: Spontaneous fractures of the femur represent one of the most serious of the potential adverse consequences of physical training.[1-3] In studies throughout the world, these catastrophic "overuse" injuries have been associated with rigorous military and intense athletic[1] training; and in these contexts, females have consistently been at higher risk than males.[4,5] Other factors that have been shown or hypothesized to increase risk of stress fractures among athletes and/or military trainees include low bone density,[6,7] younger age,[8] menstrual irregularities,[5,6] history of amenorrhea,[4] current smoking,[4] family history of osteoporosis,[4] low calcium intake,[6] and mixed military training of

Continued on page 8

Figure 1. Hospitalization rates for spontaneous fractures of the femur, active duty soldiers, by grade and gender, 1994 - 1996

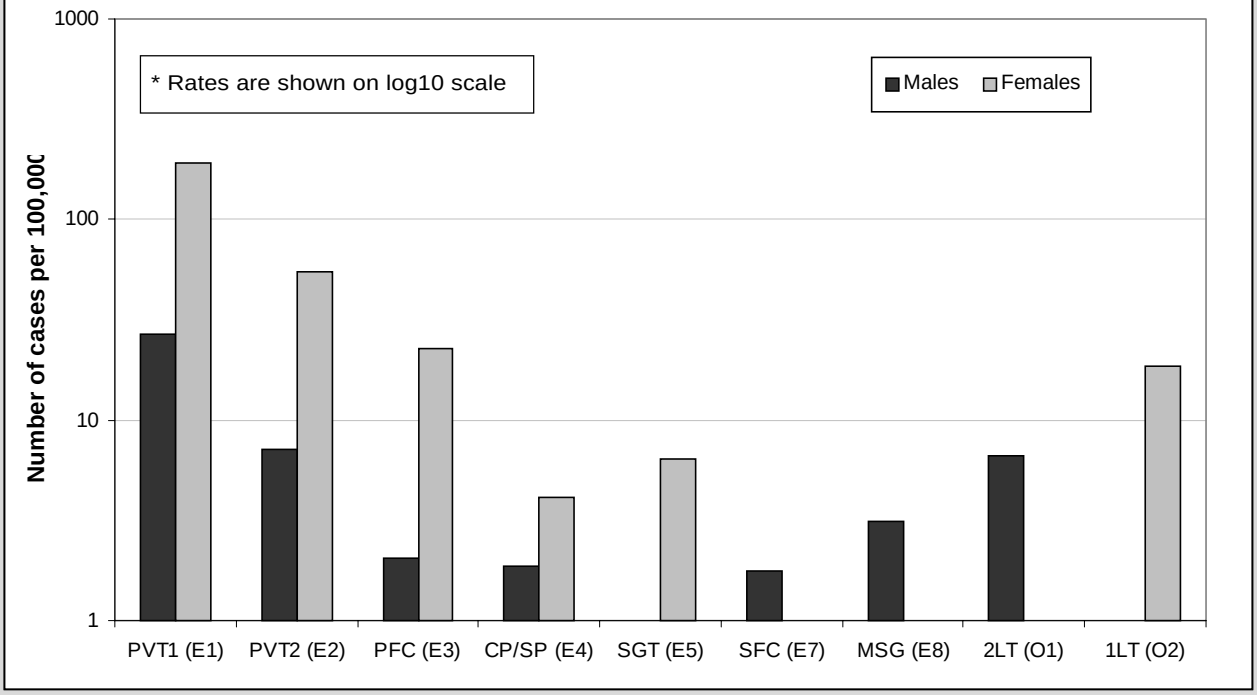


TABLE I. Selected sentinel reportable diseases, US Army medical treatment facilities* November, 1997

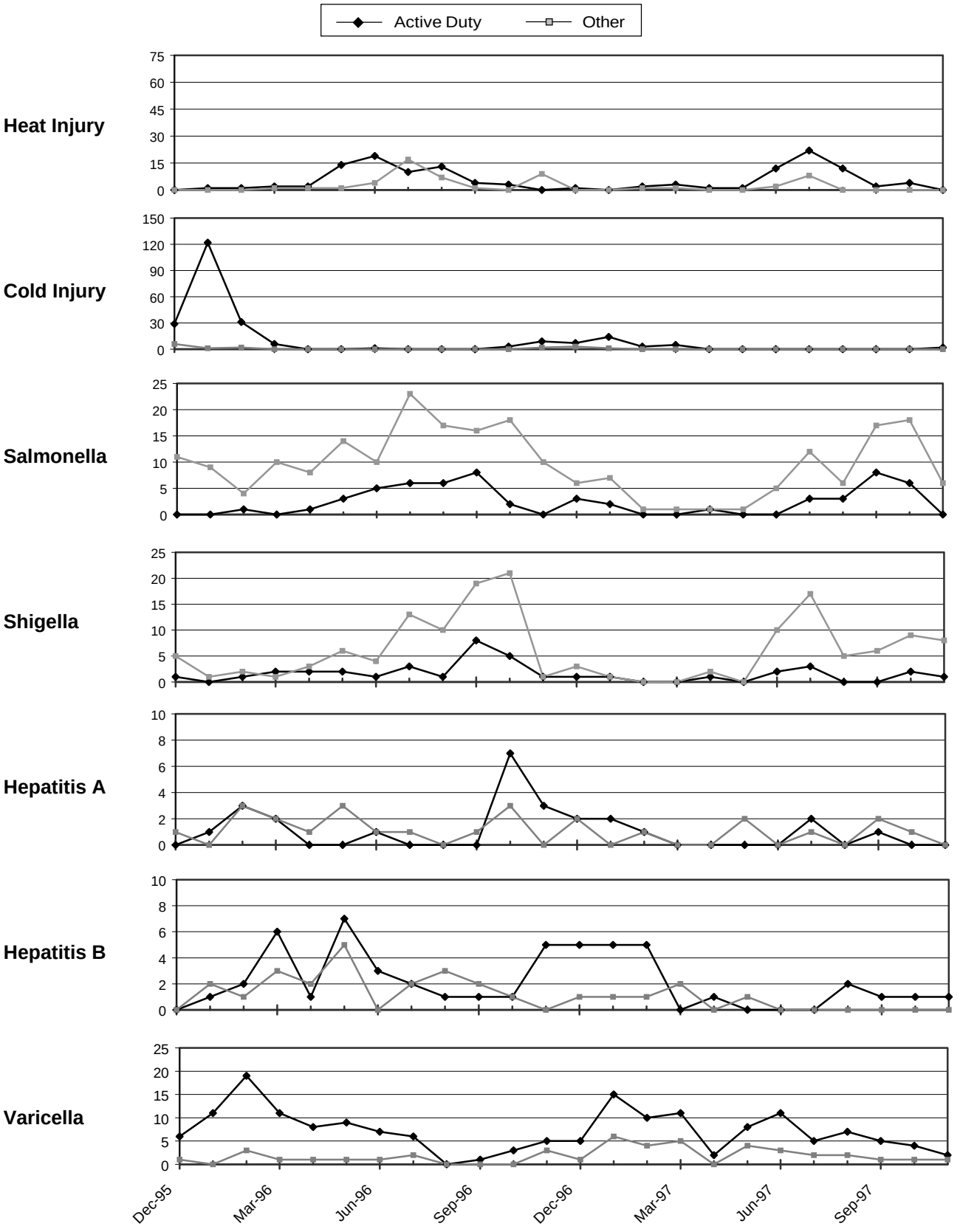
Reporting MTF/Post**	Total number of reports submitted November 1997	Environmental Injuries		Viral Hepatitis		Salmonellosis		Shigella		Varicella	
		Active Duty				Active Duty	Other	Active Duty	Other	Active Duty	Other Adult
		Heat	Cold	A	B						
		Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997
NORTH ATLANTIC RMC											
Walter Reed AMC	15	0	0	0	1	1	6	0	4	4	3
Aberdeen Prov. Ground, MD	7	1	0	0	0	0	0	0	0	0	0
FT Belvoir, VA	3	0	0	0	3	1	7	0	3	0	0
FT Bragg, NC	30	7	8	0	0	2	47	12	72	0	0
FT Drum, NY	11	5	1	0	0	0	0	0	0	5	0
FT Eustis, VA	9	9	0	1	1	0	7	0	9	5	0
FT Knox, KY	25	8	0	0	0	0	1	0	0	0	0
FT Lee, VA	0	0	0	0	0	0	0	0	0	0	0
FT Meade, MD	4	0	0	0	0	0	1	0	0	0	0
West Point, NY	5	0	0	0	1	0	1	0	0	1	0
GREAT PLAINS RMC											
Brooke AMC	17	2	0	4	0	2	4	0	5	0	0
Beaumont AMC	59	1	0	1	1	0	5	0	1	11	3
FT Carson, CO	59	2	0	1	2	1	4	0	0	0	0
FT Hood, TX	202	5	0	4	3	0	2	0	0	3	0
FT Huachuca, AZ	3	0	0	0	0	0	0	2	3	1	0
FT Leavenworth, KS	4	0	0	0	1	1	0	0	0	0	0
FT Leonard Wood, MO	6	4	2	2	0	0	0	0	0	16	8
FT Polk, LA	6	6	1	0	0	0	0	0	0	0	0
FT Riley, KS	20	5	0	0	0	0	1	0	1	0	0
FT Sill, OK	22	12	0	2	4	0	1	0	1	0	0
SOUTHEAST RMC											
Eisenhower AMC	27	0	0	0	1	0	0	0	0	0	0
FT Benning, GA	14	37	2	0	0	1	3	2	2	12	2
FT Campbell, KY	64	7	13	0	1	2	2	3	7	12	8
FT Jackson, SC	0	0	0	0	1	2	1	0	0	12	0
FT McClellan, AL	1	1	0	0	0	0	0	0	0	0	0
FT Rucker, AL	0	0	0	0	0	0	0	0	0	0	0
FT Stewart, GA	0	4	0	0	0	0	2	0	0	4	0
WESTERN RMC											
Madigan AMC	36	0	0	4	0	1	11	0	0	0	0
FT Irwin, CA	7	1	0	0	0	0	0	0	0	0	0
FT Wainwright, AK	10	0	1	0	1	0	0	0	0	0	0
OTHER LOCATIONS											
Tripler	32	2	0	1	1	0	6	0	0	0	0
Europe	60	1	1	2	18	26	39	1	5	23	0
Korea	11	7	0	0	8	1	0	1	1	6	0
Total	**769**	**127**	**29**	**22**	**48**	**41**	**151**	**21**	**114**	**115**	**24**

* Based on date of onset.

** Reports are included from main and satellite clinics. Not all sites reporting.

Date of Report: 7-Dec-97

FIGURE I. Selected sentinel reportable diseases, US Army medical treatment facilities*
Cases per month, Dec 95 - Nov 97



* Reports are included from main and satellite clinics. Not all sites reporting.

Date of report: 7-Dec-97

TABLE II. Reportable sexually transmitted diseases, US Army medical treatment facilities* November, 1997

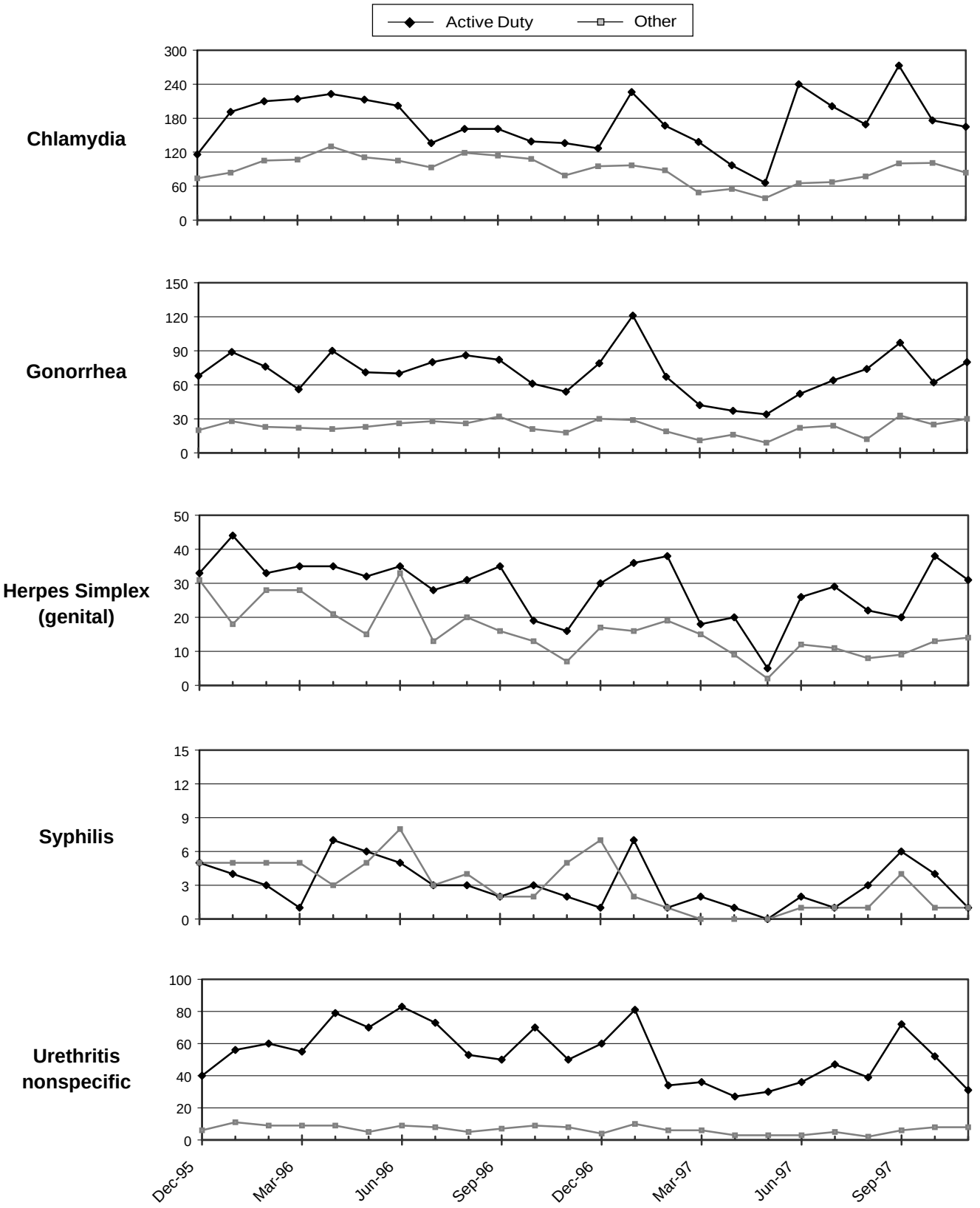
Reporting MTF/Post**	Chlamydia		Urethritis non-spec.		Gonorrhea		Herpes Simplex		Syphilis Prim/Sec		Syphilis Latent		Other STDs**	
	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997
NORTH ATLANTIC RMC														
Walter Reed AMC	1	45	1	8	2	19	5	25	0	2	0	0	0	1
Aberdeen Prov. Ground, MD	0	18	0	2	0	22	0	5	0	0	0	0	0	0
FT Belvoir, VA	2	136	0	0	0	32	1	7	0	1	0	0	0	7
FT Bragg, NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FT Drum, NY	0	85	1	6	1	34	0	4	0	3	0	0	0	0
FT Eustis, VA	5	117	0	0	2	24	1	1	0	1	0	1	0	0
FT Knox, KY	11	110	0	0	3	52	1	40	0	0	0	2	0	0
FT Lee, VA	0	13	0	0	0	8	0	0	0	0	0	0	0	0
FT Meade, MD	1	11	0	8	0	2	0	4	0	0	0	0	0	0
West Point, NY	2	4	0	0	0	0	0	0	0	0	1	1	0	0
GREAT PLAINS RMC														
Brooke AMC	8	154	0	0	3	48	1	9	0	0	0	0	0	0
Beaumont AMC	13	277	0	0	5	57	8	51	0	2	0	1	0	2
FT Carson, CO	29	279	20	215	4	71	7	52	0	0	0	1	0	0
FT Hood, TX	65	611	8	172	41	345	5	55	0	8	0	3	0	5
FT Huachuca, AZ	0	34	0	0	0	4	0	3	0	0	0	0	0	0
FT Leavenworth, KS	2	27	0	0	1	6	0	0	0	0	0	0	0	0
FT Leonard Wood, MO	1	82	0	26	0	27	0	0	0	0	0	1	0	0
FT Polk, LA	3	56	0	0	2	18	0	5	0	0	0	2	0	3
FT Riley, KS	21	181	0	0	8	41	0	0	0	0	0	1	0	1
FT Sill, OK	2	168	2	40	6	72	0	11	0	0	0	0	1	7
SOUTHEAST RMC														
Eisenhower AMC	8	94	0	0	3	28	3	44	0	1	0	0	0	8
FT Benning, GA	3	63	0	0	6	64	3	31	0	1	0	2	0	0
FT Campbell, KY	41	279	0	0	16	164	0	22	0	0	0	1	0	1
FT Jackson, SC	0	645§	0	0	0	18	0	41	0	1	0	0	0	3
FT McClellan, AL	0	7	0	0	0	5	0	1	0	0	0	0	0	1
FT Rucker, AL	1	11	0	0	1	2	0	1	0	0	0	0	0	0
FT Stewart, GA	0	100	0	141	0	92	0	53	0	0	0	2	0	27
WESTERN RMC														
Madigan AMC	13	237	7	108	0	57	3	48	0	0	0	0	0	0
FT Irwin, CA	0	39	0	0	0	7	0	4	0	1	0	0	0	0
FT Wainwright, AK	2	12	0	0	0	0	0	1	0	0	0	0	0	0
OTHER LOCATIONS														
Tripler	11	141	0	0	6	46	6	81	0	0	0	0	0	0
Europe	0	549	0	10	0	136	0	29	0	3	0	0	0	2
Korea	4	30	0	0	0	2	1	2	0	0	0	0	0	0
Total	**249**	**4615**	**39**	**736**	**110**	**1503**	**45**	**630**	**0**	**24**	**1**	**18**	**1**	**68**

* Reports are included from main and satellite clinics. Not all sites reporting. Date of Report: 7-Dec-97

** Other STDs: (a) Chancroid (b) Granuloma Inguinale (c) Lymphogranuloma Venereum (d) Syphilis unspec. (e) Syph, tertiary (f) Syph, congenital

§ Includes participants in a large-scale ongoing chlamydia study (females only).

FIGURE II. Reportable sexually transmitted diseases, US Army medical treatment facilities*
Cases per month, Dec 95 - Nov 97



* Reports are included from main and satellite clinics. Not all sites reporting.

Date of report: 7-Dec-97

Spontaneous fractures of the femur among active duty soldiers, October 1993 - June 1997

	Cases	% of total
Gender		
Female	43	52%
Male	39	48%
Age group		
< 20	19	23%
20-24	41	50%
25-29	15	18%
30-34	4	5%
35-39	3	4%
≥ 40	0	0%
Race/ethnicity		
White, nonhisp	61	74%
Black, nonhisp	12	15%
Hispanic	5	6%
Asian / Pacific Islander	2	2%
Amer-Indian / Alaskan Native	1	1%
Other	1	1%
Grade		
E1 (PVT1)	39	48%
E2 (PVT2)	18	22%
E3 (PFC)	9	11%
E4 (CPL, SPC)	7	9%
E5 (SGT)	3	4%
E6 - 9 (SSG - SGM)	3	4%
O1, O2 (2LT, 1LT)	3	4%
Location (> 2 cases)		
Ft. Sam Houston, TX	14	17%
Ft. Benning, GA	9	11%
Ft. Knox, KY	9	11%
Ft. Leonard Wood, MO	9	11%
Ft. Gordon, GA	7	9%
Ft. Jackson, SC	6	7%
Ft. Lewis,WA	4	5%
Ft. Lee, VA	3	4%
Ft. Sill, OK	3	4%
Military occupational specialty		
Medical (91 series)	15	18%
Infantry (11 series)	11	13%
Commo (31 series)	9	11%
Armor (19 series)	6	7%
Vehicle repair (63 series)	4	5%
Personnel (75 series)	4	5%
Supply/Lab (92 series)	4	5%
Engineer (12 series)	3	4%
Wpns repair (45 series)	3	4%
Construction (51 series)	3	4%
Admin spt (71 series)	3	4%

Continued from page 3

male and female recruits.[9] Finally, black nonhispanic soldiers have consistently been protected from stress injury risk in relation to white nonhispanic or ethnic minority soldiers.[4,10]

The recent experiences at Fort Leonard Wood and in the Army overall document that spontaneous femoral fractures continue to occur sporadically and in clusters,[10] particularly among females during basic and advanced individual training. Thus, there remains a need for innovative training techniques that will assure the attainment of high levels of physical fitness while minimizing risks of overuse injuries, particularly among females in basic and advanced individual training.

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Figure 2. Spontaneous fractures of the femur among active duty soldiers, by length of military service, October 1993 - June 1997

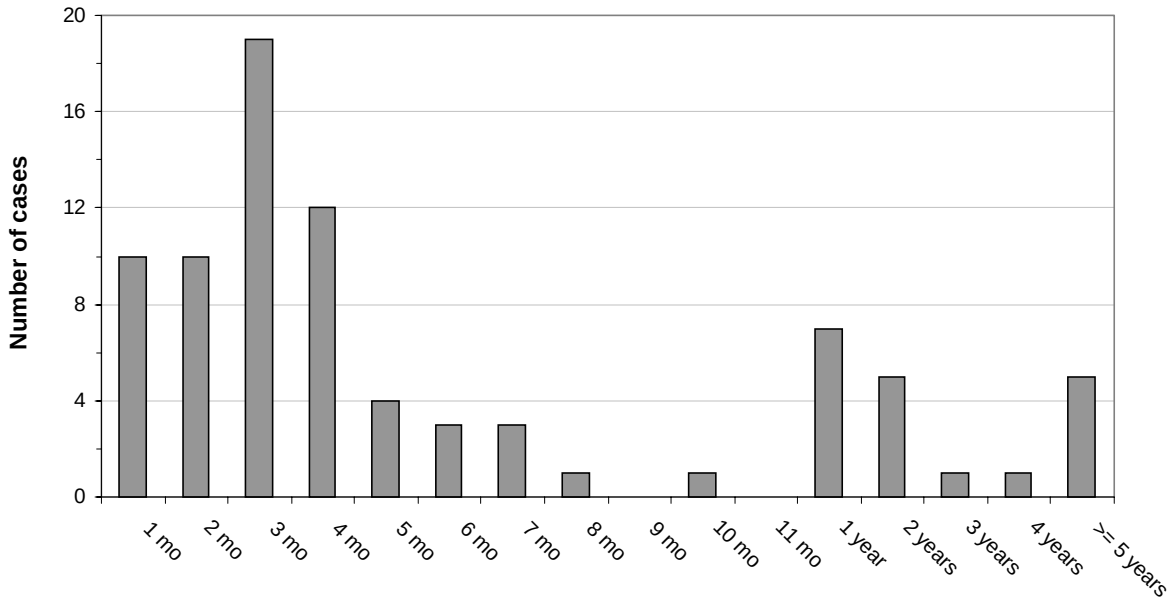


Figure 3. Spontaneous fractures of the femur among active duty soldiers, by gender, 1994-1996

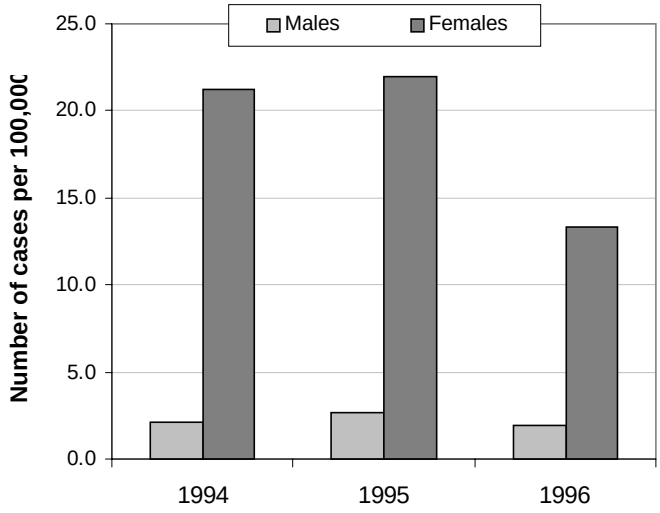
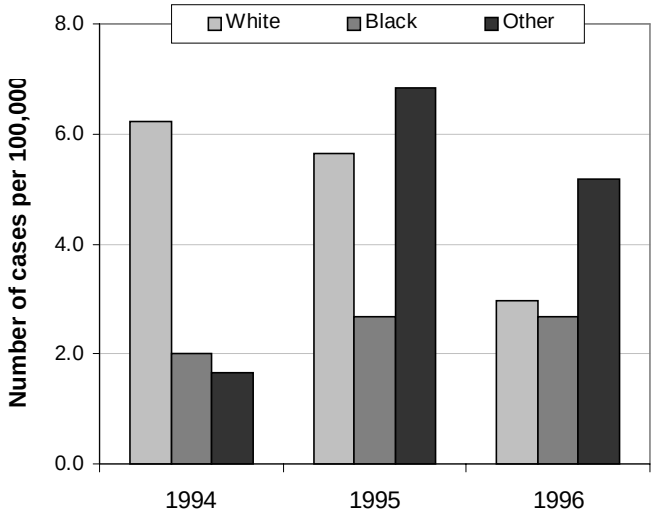


Figure 4. Spontaneous fractures of the femur among active duty soldiers, by race, 1994-1996



Local Surveillance

Injury Incidence in Soldiers Attending Medical Specialist (MOS 91B) AIT, Fort Sam Houston, Texas

Surveys conducted during basic combat training (BCT) have consistently shown that women suffer approximately twice the cumulative incidence of injuries as men. Other studies have documented that 23-28% of men and 42-67% of women seek care at least once from a medical treatment facility during the eight-week course of basic training (1-4). Until recently, gender-specific injury incidence rates beyond basic training were unknown because military groups that had been studied (e.g., infantry, combat engineers, field artillery) had no female members (5-7). During the winter 1996-1997, a survey was conducted to assess gender-specific injury experiences during advanced individual training (AIT). The Clinical Research Center at Brooke Army Medical Center, in cooperation with the Center for Health Promotion and Preventive Medicine, examined injuries in soldiers attending the ten week Medical Specialist (MOS 91B) AIT training course at Fort Sam Houston, Texas. Preliminary results of the survey are presented in this report.

Methods: Medical records were reviewed to document injuries during BCT and for the period of attendance at AIT among all soldiers enrolled in medical specialist (MOS 91B) advanced individual training at Fort Sam Houston, Texas. Cases were defined as soldiers with a recorded medical incident related to an injury. Some students were attending medical specialist training as part of a "split option." The "split option" program allows soldiers to attend BCT, leave active service to complete a year of civilian schooling, and then return to complete advanced individual training. A total of 438 men and 287 women were included in the survey.

Results (figure): The injury experiences of survey participants during BCT were similar to those documented in other studies: in BCT, 27% of the men and 52% of the women were treated at least once for an injury (female:male cumulative incidence ratio (F:M CIR): 1.93, $p<0.01$). In AIT, however, injury rates among men and women were similar: 24% of the men and 30% of the women were treated at least once for an injury during 91B AIT (F:M CIR: 1.25, $p=0.08$).

Injury rates among men and women who split basic and advanced individual training ("split option") were 26% and 43%, respectively (F:M CIR: 1.65, $p<0.01$). Thus, injury rates did not significantly vary between "split option" and "non-split option" men ($p=0.49$), but they were remarkably higher among "split option" compared to "non-split option" women ($p<0.01$).

Conclusion: Results of this survey suggest that injury rates among men and women during AIT are relatively comparable when AIT immediately follows BCT. This finding in AIT contrasts with the experience in BCT during which gender-specific injury rates significantly vary. An interesting finding of the survey was that women (but not men) who "split" their basic and advanced individual training

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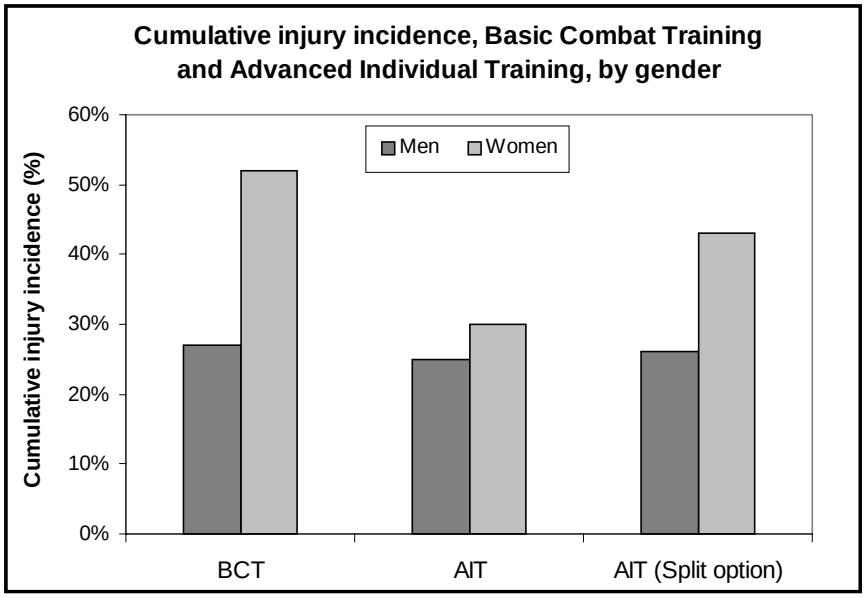

ARD Surveillance Update

Legend

ARD Rate = (ARD cases / Trainees) * 100

SASI* = ARD Rate * Strep Rate**

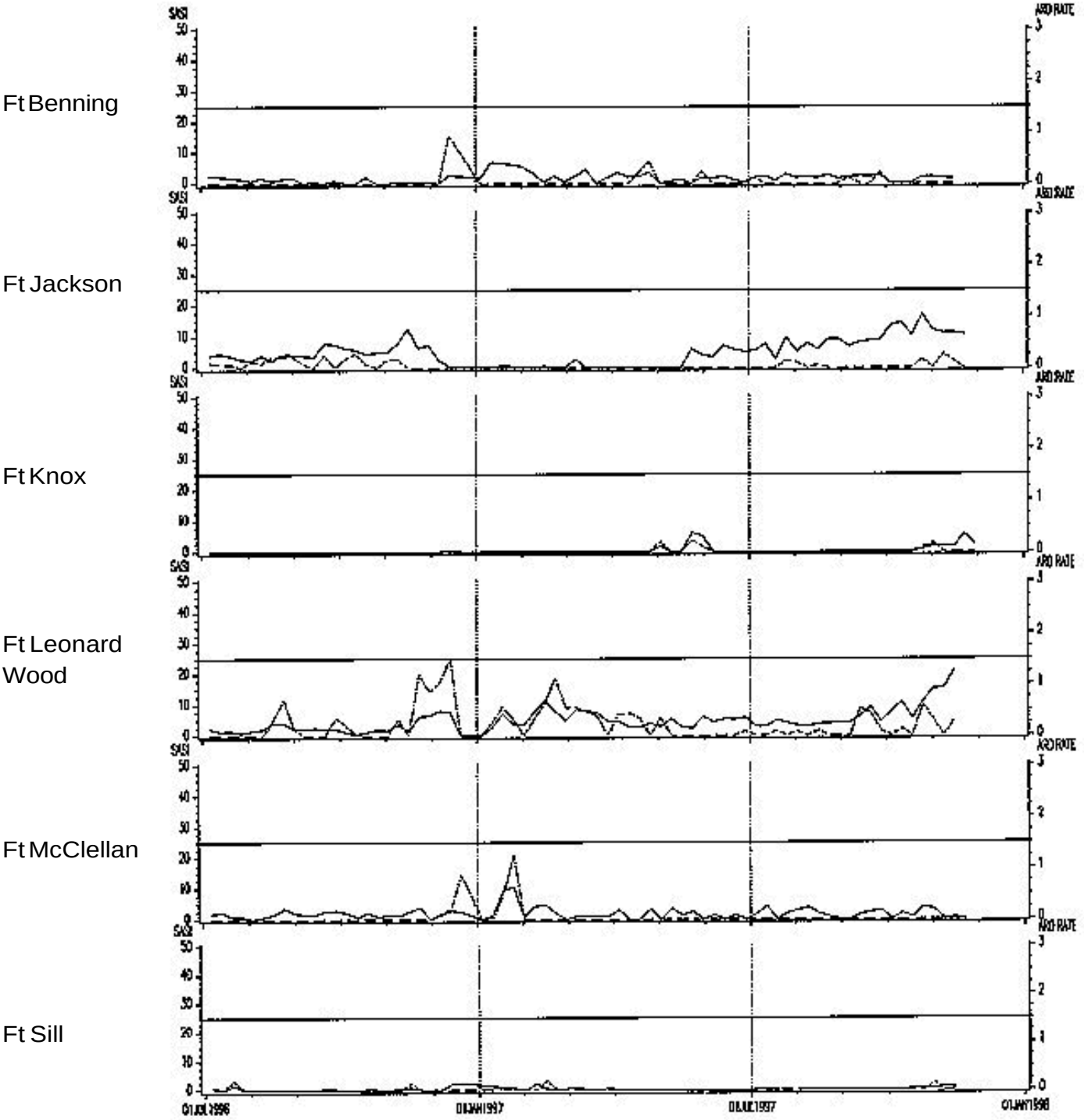

Figure III. ARD surveillance rates, submitted by Army TRADOC posts

* Strep/ARD Surveillance Index (SASI)

**Strep Rate= (GABHS(+) / Cultures) *100

Note: SASI has proven to be a reliable predictor of serious strep-related morbidity, especially acute rheumatic fever.

Continued from page 10

had significantly more injuries during AIT than "non-split option" women. The reasons for the higher risk among "split option" women are not clear. It is possible that adaptations to physical stress made during BCT were lost during the extended period between BCT and AIT. If so, the enhanced injury risk associated with such losses appear to affect predominately women. The survey indicates the value of and the continued need for studies of military units with mixed gender populations in both operational and training settings.

Report submitted by Joseph Knapik, PhD, Directorate of Epidemiology and Disease Surveillance, USACHPPM, and Nancy Henderson, LTC, Clinical Research Center, Brooke Army Medical Center, Ft. Sam Houston, TX.

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Case Report

Measles, Madigan Army Medical Center

In September, an 18 month-old boy presented to the Emergency Department (ED) of the Madigan Army Medical Center with a chief complaint of fever to 105° F, nasal discharge and cough. The parents stated he had been ill for about 4 days. Physical examination was normal with the exception of a mildly erythematous tympanic membrane, rhinorrhea, and a "papular lesion" in the posterior oropharynx. No rash was noted. The patient was treated with amoxicillin for a presumed otitis media, and he was discharged from the ED approximately 4 hours after arrival.

The patient returned the next evening, with a chief complaint of "rash all over". The father stated, "I think he has the measles". Subsequent travel history revealed that the patient had just returned from Tonga (an island nation near New Zealand) where the parents were told that "measles are going around." The patient had not received his initial MMR (the normal vaccination window is 12-15 months). The patient was released without further therapy and recovered without sequelae. Serum drawn at the second ED visit was positive for rubeola (measles) antibody.

Because of the highly contagious nature of measles, an extensive contact investigation was performed following diagnosis. The ED followed correct procedures by immediately notifying both the Ft. Lewis Preventive Medicine Activity and the Tacoma-Pierce County Public Health Department. In total, 140 patients were in the emergency room or waiting area at or near the same time as the index case. An unknown number of family members and friends who accompanied the patients were also exposed. More than 20 staff members were exposed to the patient. In addition, fellow

passengers and the crew on the return flight from Tonga were potentially exposed.

The table below summarizes categories of risk for contacts of a measles case. Of the 140 contacts in the ED, the Preventive Medicine Service identified five patients in the highest risk category. Each of these patients was given either an MMR vaccine (acceptable for prophylaxis if given within 72 hours and at least 6 months of age) or immune globulin. An attempt was made to contact the passengers of the flight from Tonga. Unfortunately, the manifest had been destroyed. No secondary measles cases have been detected at Fort Lewis.

Comment: Measles still occurs with regularity throughout the world, but it has become rare in the United States. Aside from a recent outbreak in the early 1990's, the incidence of measles has fallen steadily, with only 508 cases reported in the U.S. last year. Of these cases, 73% were epidemiologically or virologically linked to imported cases. In fact, transmission of the measles virus has been interrupted repeatedly in the U.S. only to be reintroduced by importation. Worldwide, the incidence of measles was reduced by 78% between 1989 and 1996. Nonetheless, an estimated 1 million children die of measles each year.

Although now rare in the US, measles is still common in many countries. A complete travel history should be obtained for any febrile illness, especially in young patients who may not have received the measles vaccine. Even though the US population is highly immunized, imported cases can lead to substantial outbreaks resulting in scores of infections. Maintenance of low numbers of cases in the US will depend upon prompt control and containment measures. In this particular case, prompt notification of the Preventive Medicine Service by the ED staff was a key factor in aborting a potentially large outbreak.

Measles is highly contagious. The causative organism, rubeola virus, belongs to the genus Morbillivirus of the family Paramyxoviridae. The virus causes disease only in humans; there is no known animal reservoir. Measles is spread by direct contact with droplets from respiratory secretions of infected persons. The virus remains infective in droplet form in air for several hours, especially under conditions of low humidity.

The incubation period of measles is 10-14 days. A prodromal phase, lasting several days, begins after the incubation period and coincides with secondary viremia. Typical symptoms include fever, cough, and coryza. Toward the end of the prodrome, Koplik spots (bluish gray specks on a red base, most prominent near the second molars) appear. This is the period of peak infectivity. Next, the measles rash appears, usually beginning on the face and spreading centripetally down the body to involve the extremities, including palms and soles. The rash usually persists for about 5 days. The entire uncomplicated illness from prodrome to resolution of rash lasts 7-10 days. The most common complications of measles are pneumonia (accounting for 60% of deaths in infants) and encephalitis.

Report submitted by Andrew Wiesen, MAJ, MC, Preventive Medicine Service, Madigan Army Medical Center, Fort Lewis, WA.

Categories of risk for contacts of a measles case

Low risk:	Born before 1958—presumed immune from environmental exposure to wild type virus
	Documented primary series and one booster of MMR vaccine
	Documented positive rubeola antibody titer
Moderate risk:	Born after 1958—primary series of MMR vaccine, but no documented booster
High risk:	No documented MMR vaccine
Highest risk:	Age <12 months (no primary MMR vaccination)

Reports from the Field

Carbon Monoxide Intoxication, Fort Hood, Texas, and Fort Campbell, Kentucky

Case reports, Fort Hood, Texas

In early November, an active duty soldier awoke at approximately 0200 hours feeling nauseated and dizzy. He awakened his wife, also a soldier, who had similar symptoms. Their conditions improved when they went outside, but they went to the local Emergency Department (ED) for evaluation and treatment.

In the ED, the husband complained of nausea and dizziness. He was otherwise asymptomatic. He denied alcohol and tobacco use, and his physical examination was unremarkable. Pulse oximetry was 97% on room air, and his initial carboxyhemoglobin was 31.6%. After two and one half-hours on 100% oxygen via a non-rebreather mask, his carboxyhemoglobin had decreased to 6.1%, and his symptoms had resolved.

On presentation to the ED, the wife complained of nausea, dizziness and difficulty walking. She gave a history of "passing out." She denied alcohol and tobacco use. Her physical examination was notable for ataxia (the rest of her neurologic examination was normal). Pulse oximetry was 98%, and her initial carboxyhemoglobin was 28.3%. She was also placed on 100% oxygen with a non-rebreather mask. After two and one half hours, her carboxyhemoglobin was 3.3%, and her symptoms were resolved.

Both soldiers were diagnosed with moderate carbon monoxide poisoning and transferred for hyperbaric oxygen therapy.

The couple lived in a duplex apartment off post. Their residence did not have carbon monoxide detectors. The furnace that heated their residence was turned on the night before and was identified as the source of the carbon monoxide.

Case report, Fort Campbell, Kentucky

In late November, the wife of a soldier awoke in the morning with headache, fatigue and difficulty standing. She presented to the local Emergency Department where she had a carboxyhemoglobin concentration of 33%. She was a non-smoker. She was treated with 100% oxygen and discharged to home without complication.

The patient lived off post in a trailer equipped with a carbon monoxide detector. When the detector alarmed the day prior to her ED visit, the landlord told her that it was installed too close to the furnace. She moved the detector, but it continued to alarm. She assumed it had not been reinstalled appropriately. A subsequent investigation revealed that the furnace had a clogged flue.

Armywide experience: Between 1990 and 1996, there were 56 soldiers hospitalized with a primary diagnosis of carbon monoxide intoxication (ICD9: 986.0). The overall hospitalization rate was 1.30 per 100,000 soldiers per year. Hospitalization rates were higher among males (n=52, rate: 1.38 per 100,000 pers-yrs) than females (n=4, rate: 0.75 per 100,000 pers-yrs), were approximately twice as high among married (n=40, rate: 1.64 per 100,000 pers-yrs) than never married (n=13, rate: 0.80 per 100,000 pers-yrs) soldiers, and were approximately 50% higher among enlisted soldiers (n=50, rate: 1.37 per 100,000 pers-yrs) than officers (n=6, rate: 0.92 per 100,000 pers-yrs).

Case reports submitted by Scott Stanek, MAJ, MC, Chief, Preventive Medicine Service, Fort Hood, TX and Kevin Michaels, MAJ, MC, Chief, Preventive Medicine Service, Fort Campbell, KY.

Editorial comment: Carbon monoxide (CO) is a colorless and odorless gas that is produced by the incomplete combustion of carbon-based fuels such as wood, charcoal, gasoline, heating oil, kerosene, methane, propane, and butane. In the United States, CO intoxication generally results from inhalation of exhaust fumes of fires, internal

combustion engines (particularly automobiles), and heating systems (particularly malfunctioning furnaces).[1] CO causes more deaths and hospitalizations in the United States than any other environmental intoxicant.[2] Recent studies have documented that furnaces are the leading cause of nonfatal carbon monoxide poisoning[3] and that risks of CO poisoning are higher in northern climates, particularly during severe winter storms.[4,5] Consistent with the reports above, risks of residential CO poisoning also increase when defective or poorly maintained furnaces are turned on at the start of heating seasons.

Upon inhalation, CO combines with hemoglobin with high affinity to form the relatively stable compound, carboxyhemoglobin (COHb). Because of its relative stability, COHb inhibits the blood's overall oxygen carrying and exchange capabilities. Thus, the underlying pathophysiology of CO intoxication is progressive multi-organ hypoxia. The early stages of CO intoxication are non-specific (e.g., headache, dizziness, nausea, drowsiness, fatigue) and difficult to diagnose clinically. However, when carbon monoxide intoxication is suspected, empirical treatment with 100 percent oxygen is indicated.[6] Definitive diagnosis of CO poisoning relies on documentation of elevated concentrations of carboxyhemoglobin (>10%).

In recent years, CO detectors with audible alarms have become available for home use. Residential detectors are intended to alarm when CO concentrations rise above toxic levels but before early symptoms of toxicity. Residential CO detectors purchased for home use should meet the Underwriters Laboratory (UL) 2034 Standard. They should be installed on walls or ceilings outside of individual bedrooms to ensure the alarm is audible to all sleeping occupants. In addition, CO detectors

Consumer Product Safety Commission Recommendations for the Prevention of Carbon Monoxide Poisonings

1. Make sure appliances are installed according to manufacturer's instructions and local building codes. Most appliances should be installed by professionals.
2. Have the heating system (including chimneys and vents) inspected and serviced annually.
3. Follow manufacturer's instructions for safe operation.
4. Examine vents and chimneys regularly for improper connections, visible rust or stains.
5. Pay attention to problem symptoms that may indicate improper appliance operation:
   a. Decreasing hot water supply
   b. Furnace unable to heat house or runs constantly
   c. Sooting, especially on appliances
   d. Unfamiliar or burning odor
6. NEVER burn charcoal indoors or in a garage.
7. NEVER service appliances without proper knowledge, skills and tools.
8. NEVER use the gas range or oven for heating.
9. NEVER operate unvented gas-burning appliances in a closed room.
10. Install a CO detector for added safety. Be sure it meets requirements of UL 2034.

should be installed on each level of multilevel homes. Finally, manufacturers' instructions should be consulted to assure proper placement since this may vary slightly with the make and model. Comprehensive recommendations of the Consumer Product Safety Commission regarding the prevention of serious CO exposure are listed in the table.

Information submitted by William Statz, MAJ(P), Directorate of Clinical Preventive Medicine, USACHPPM, and Chris Carroll, Directorate of Occupational Health Sciences, USACHPPM.

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Surveillance Trends

U.S. Army Hearing Conservation Program (HCP): Assessment of Long Term Performance

For several decades, the Army's Hearing Conservation Program (HCP) has systematically collected results of audiometric evaluations among civilian workers. Recently, data relevant to 52,830 participants enrolled in the HCP between 1968 and 1990 were analyzed to assess the program's performance. The overall performance was characterized in relation to decreasing, unchanged, or increasing incidence rates of hearing loss among HCP participants over time.

Methods

For the analysis, a case of "hearing loss" was defined as a 10-db loss of hearing threshold in either ear for the averaged measurements at 2, 3, and 4 kHz. This case definition was consistent with the Occupational Safety and Health Administration's (OSHA) standard for "threshold shift." Participants enrolled in the HCP between 1968 and 1990 were distributed into cohorts based on their years of enrollment (thus, for example, employees who enrolled in 1982 comprised the "1982 enrollment-year cohort"). Members of each enrollment year cohort were followed for a three year period after their enrollment in the HCP until they developed hearing loss or until the study period ended. Each subject's baseline audiogram was compared with subsequent annual audiograms taken during the followup period, and the date of the first audiogram in which hearing loss was detected was considered the date of onset. Since few employees were enrolled before 1980, results are presented only for those enrolled between 1980 and 1990 (hence, 11 enrollment-year cohorts were followed).

Cumulative incidence (%) and incidence rates of hearing loss were calculated for each enrollment-year cohort — in age, gender, and race/ethnicity defined subgroups. Relative hazards of hearing loss incidence were estimated using Cox's proportional hazards regression model. Because

Table 1. Characteristics of DA civilian participants in the HCP

Racial/ethnic group	Male	%	Female	%	Total	%
White	38303	78%	2902	71%	41205	80%
Black	4748	10%	720	17%	5468	10%
Hispanic	3874	8%	237	6%	4111	7%
Other	1788	3%	258	6%	2046	3%
Total	48713		4117		52830	
Age group						
<25	2226	5%	321	9%	2547	5%
25-34	13656	33%	1421	39%	15077	33%
35-44	16333	39%	1219	33%	17552	39%
45-54	8342	20%	555	15%	8897	20%
55-64	1318	3%	121	3%	1439	3%
>64	56	0%	3	0%	59	0%
Missing	6782		477		7259	

of the size and representativeness of the 1984 enrollment-year cohort, its experience was used as the referent (i.e., relative hazard=1.0). Thus, the regression model estimated enrollment-year-specific relative hazards (in relation to the 1984 enrollment-year cohort) while adjusting for the potentially confounding effects of age, race, and hearing threshold at entry.

Results

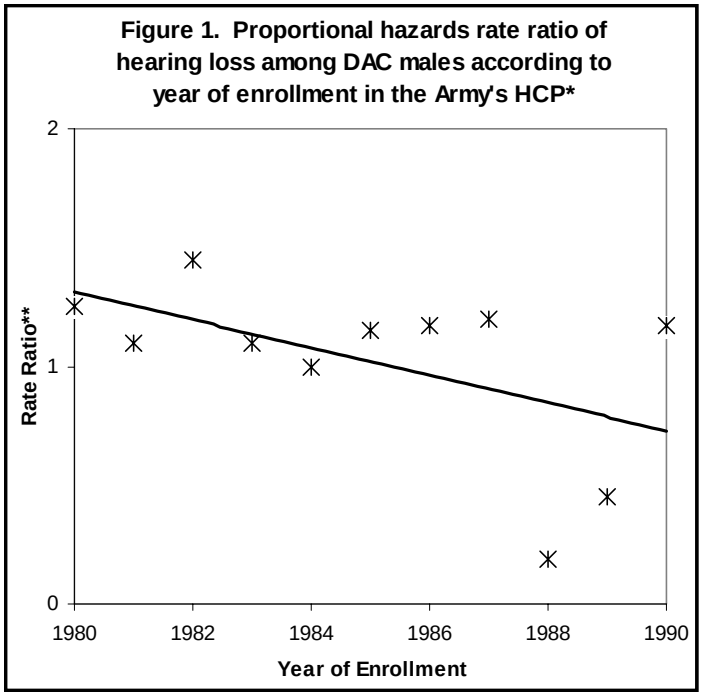
Demographics (table 1): Approximately 80% of the HCP participants were white. Black, Hispanic, and other racial/ethnic subgroups each accounted for 10% or less of the total. Approximately 8% of participants were female. Nearly 3 of 4 (72%) enrollees were between the ages of 25 and 44.

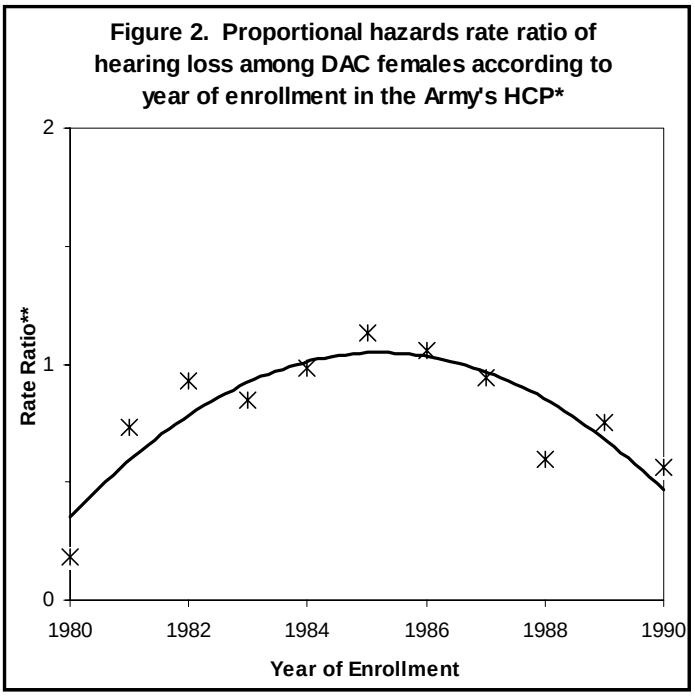
Cumulative incidence (table 2): Among male and female workers, hearing loss significantly increased with age. The cumulative incidence of hearing loss for both genders was approximately two-fold higher among workers older than 44 compared to those younger than 25. In addition, in each age group (up to age 64), hearing loss was approximately twice as prevalent among male workers compared to females.

Incidence rates (table 2): Among males, incidence rates approximately tripled from 6.8 cases per 100 persons/year in those younger than 25 to 19.4 per 100 persons/year in those 55 to 64. Among females, hearing loss incidence rates increased much more gradually and were less than 10 per 100 persons/year in all age groups younger than 64.

Table 2. Hearing loss cumulative incidence (%) and incidence rates per 100 person-years among DA civilian HCP participants, by gender

	Male			Female		
Age group	**N**	**CI (%)**	**IR / 100**	**N**	**CI (%)**	**IR / 100**
<25	2,135	15.3	6.8	311	8.7	3.7
25-34	13276	24.1	10.3	1393	11.1	5
35-44	16011	29.3	13.1	1193	13.7	6
45-54	8211	34.7	16.3	547	21.8	9.9
55-64	1208	38.9	19.4	120	20.8	9.8
>64	46	34.8	16.4	3	66.7	65.2





* Adjusted for age, race, and hearing threshold at entry; regression line weighted by cohort size. ** RR (1984 cohort) = 1.0.

Proportional hazards regression analyses (figures 1 and 2): Examination of the weighted regression lines based on rate ratios for each year of enrollment revealed a decreasing trend for females since the mid-1980s and for males since the early 1980s.

Discussion: Examination of hazard rate ratios by year of enrollment does not reveal striking patterns, except for the unusually low rate ratios in 1988 and 1989. Such an assessment suggests that rates of hearing loss remained relatively stable during the follow-up period. However, examinations of weighted regression lines reveal gradually decreasing trends since the early and mid-1980s among males and females, respectively. The conclusion of such analyses is that there was sustained improvement in HCP performance during the period. The latter assessment seems more reliable since it is based on data summaries (i.e., smoothed regression curves) that are weighted by the size of the cohorts.

Reasons for the apparent improvement in the HCP's performance are unclear. In 1987, the Army changed from manual recording of audiometric test results to the automated Hearing Evaluation Automated Registry System (HEARS). HEARS produces accurate and consistent audiometric readings which enable more reliable standard threshold shift calculations. A recent study concluded that these technological innovations may have significantly contributed to the apparent improvements in HCP performance.[1] Enhanced adherence to HCP protocols among program administrators and participants may also have affected overall performance. Additional studies are needed, however, to identify the factors that are significant determinants of the Army's HCP performance and to characterize the nature and magnitudes of their effects.

Report provided by Tilahun Adera, PhD, MPH, Cyrus Amir, PhD, Lisa S. Anderson, MPH, Program for Hearing Loss Research, Medical College of Virginia, Virginia Commonwealth University; Dr. Tom Helfer, Dr. Doug Ohlin, Hearing Conservation Program, Directorate of Clinical Preventive Medicine, USACHPPM.

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